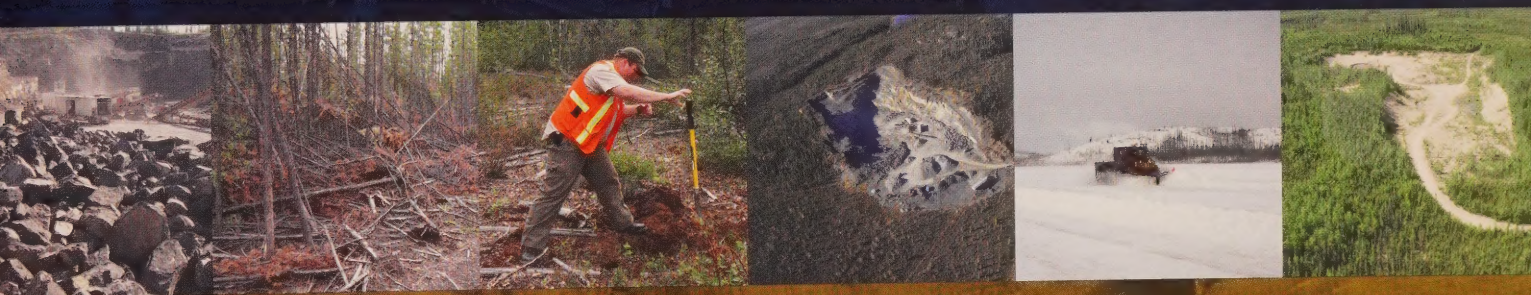
Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

VOLUME 07

NORTHERN LAND USE GUIDELINES

Pits and Quarries



Canada

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Preface

Indian and Northern Affairs Canada (INAC) has revised its popular land use guidelines series. It is designed to guide land use activity on Crown land in the Northwest Territories and Nunavut. Activities on land under private ownership (e.g., First Nations or Inuit-owned land)[1] and land under municipal or territorial control (e.g., Commissioner's land) require direction from the appropriate agency.

Guidelines apply to land use activities on Crown land only.

These guidelines will assist proponents and operators in planning proposed land use activities, assessing related environmental effects and minimizing the impacts of these activities. They should be supplemented by local research, traditional knowledge, engineering or other professional expertise specific to a proposal and advice from the appropriate regulatory agency. Although every attempt has been made during the preparation of these guidelines to use up-to-date information, it remains the operator's responsibility to obtain the most recent information related to northern resource development and to follow current regulatory requirements.

Guidelines do not replace acts, ordinances, regulations and permit terms and conditions.

[1] Aboriginal land refers to First Nations, Inuit, or Métis owned lands

Volumes in this series include:

- Vol. 01 Administrative Framework
- Vol. 02 Administrative Process
- Vol. 03 Applying Sustainable Development
- Vol. 04 Permafrost
- Vol. 05 Access: Roads and Trails
- Vol. 06 Camp and Support Facilities
- Vol. 07 Pits and Quarries
- Vol. 08 Mineral Exploration
- Vol. 09 Hydrocarbon Exploration
- Vol. 10 Other Land Uses
- Vol. 11 Abandonment and Reclamation

The series is available electronically at **www.publications.gc.ca**. Readers are encouraged to visit the site for updates and revisions to the series.

For further information concerning the subject matter contained in this guideline series, please contact:

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YUKON

NOTE: *Effective April 1, 2003, responsibility for Indian and Northern Affairs Canada's Northern Affairs Program (land and resource management) was transferred to the Government of Yukon. For information on land-use in the Yukon, contact the office below:*

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Acknowledgements

In the 1980s, Indian and Northern Affairs Canada published a series of six guidelines in a handbook format, intended to help operators of small to medium-scale projects carry out activities in northern Canada in an environmentally sensitive manner. These handbooks, commonly called "The Blue Books," have been widely distributed and quoted. Their success is a tribute to the efforts of the original authors and contributors, and to the departmental steering committee that guided their preparation.

This new series of northern land use guidelines is, in part, an update of the earlier series. This work was directed by a steering committee made up of Northern Regional Office staff and Northern Affairs Program staff in Ottawa. Much of the information and many of the photographs presented in this series were obtained in consultation with land use administrators and resource managers in the Northwest Territories and Nunavut.

CHAPTER
01

Introduction

The purpose of this volume is to provide guidance to pit and quarry operators when operating on Crown land in the Northwest Territories and Nunavut. If you are not operating on Crown land, it is your responsibility to contact the appropriate landowner for any land use guidelines that may be in place.

Granular resources are a strategic and valuable resource, and it is important that they be used in a sustainable way. This volume presents land use techniques and current industry best practices that can be used by operators to minimize land disturbances and environmental impacts. The guidelines are general in nature and should be supplemented, on a site-specific basis, by engineering and other expertise.

CHAPTER 02

Northern Granular Resources

The term granular resources describes a wide range of materials, from silts to sands, gravel and cobbles. These are vital for the construction of a wide range of northern developments, including roads, pipelines, mines and community infrastructure. Granular materials can also be used for smaller scale activities, such as carving. Access to granular materials is often a challenge in the North because development activities are commonly located in remote areas with limited infrastructure. The availability of granular resources is often an important factor in determining how and if a proposed development can proceed.

Pit and quarry development requires that vegetation, topsoil and overburden be removed before drilling and blasting are used to excavate granular material. In order to minimize environmental effects and prevent wasting granular resources, proper land use techniques and extraction methods should be used.

Pits and quarries are defined by the type of granular material extracted and the method of extraction (Table 2-1).

Table 2 1. Definitions of pits and quarries

QUARRY	PIT
• Extraction of rock materials by digging, cutting or blasting • Quarries usually yield large stone that may then be crushed • Commonly quarried materials include limestone and granite	• Excavation of finer grained fill material, such as gravel, sand, clay, marl and topsoil • At a smaller borrow pit, the material is normally used at a nearby site
	

2.1 Evaluating Granular Deposits

Different types of granular resources have different uses. The proponent must evaluate the source material to ensure that it has the characteristics required for its intended use. Higher quality material should be reserved for those uses that require it, not for uses satisfied by lower quality material. Each material and deposit has unique characteristics that will require a slightly different approach to development.

The feasibility of using an existing pit or quarry should be assessed as this can be more economical and better for the environment. For example, the proponent should identify if a suitable source already exists within 10km of the site where the material is needed. Use of an existing source would reduce hauling costs and the environmental footprint associated with the creation of a new quarry or pit.

If a new granular source must be developed, site investigations should be conducted to verify the:

- type, extent and geology of the granular deposit;
- grade and quality of the deposit;
- structural and chemical properties of the rock; and
- extent of ground ice in the material.

If results from these investigations show that the granular material is suitable for its intended use, the proposed development is ready to proceed through the four phases of land use activity:

1. Planning and Design
2. Site Development
3. Operations and Monitoring
4. Closure and Reclamation

2.2 Permitting Requirements

In the Northwest Territories and Nunavut, quarrying activities on federal Crown land require a quarry permit and will often require a land use permit. Other authorizations may be required depending on the nature of the development. The purpose and responsible authority for these authorizations are outlined in Table 2-2. Contact regulatory authorities early to understand the requirements and time frames necessary to obtain required permits. For more information on regulatory processes and applicable legislation, consult the *Administrative Process* volume of this series.

2.2.1 Quarrying Permit/Quarry Lease

Quarrying permits are issued by INAC under the Territorial Quarrying Regulations. Quarrying permits and quarry leases specify how operations will be conducted and reporting requirements for materials that are used. Examples of quarrying permit applications for the Northwest Territories and Nunavut are presented in Appendix A. In Nunavut, a quarry lease may be applied for instead of a quarrying permit if longer term tenure is desired.

Applications for quarrying permits are assessed by INAC to determine:

- the need for a new pit or quarry, and the availability of an existing one;
- if potential reserves of the granular material are adequately identified and assessed; and
- if the application and proposed development plan maximize appropriate use of granular resources, especially in areas where these materials are scarce.

Extraction of granular materials from water bodies and shorelines is not normally allowed unless there are no alternatives. A water licence and fisheries authorization will also be required.

Under Section 10 of the Territorial Quarrying Regulations, residents of the Northwest Territories and Nunavut are allowed to take up to 38 m^3 (50 cubic yards) of sand, gravel or stone per calendar year for their own personal use without having to obtain a quarrying permit or pay any fees. This does not apply if any interest in the surface rights of lands has been licensed, leased or otherwise disposed of by the Crown.

Table 2-2. Authorizations that may be required for quarrying operations

PERMIT	PURPOSE	RESPONSIBLE AUTHORITIES
Quarrying Permit	Obtain quarry materials	Indian and Northern Affairs Canada
Quarry Lease	Long-term access to quarry materials	Indian and Northern Affairs Canada (Nunavut only)
Land Use Permit	Use and occupation of land associated with site investigations, geotechnical work and quarrying	Indian and Northern Affairs Canada (Inuvialuit Settlement Region) Land and Water Boards (Mackenzie Valley)
Water Licence	Use of water or deposition of waste into water, for example, water use for gravel washing, pit dewatering, or building structures that affect watercourses, such as culverts	Northwest Territories Water Board (Inuvialuit Settlement Region) Land and Water Boards (Mackenzie Valley) Nunavut Water Board
Fisheries Authorization	Work in fish-bearing waters, for example, installation of a culvert	Fisheries and Oceans Canada
Timber Permit	Clearing timber prior to quarrying	Government of the Northwest Territories (NWT only)
Explosives Authorizations	Possession, transportation and use of explosives	Natural Resources Canada Workers' Safety and Compensation Commission
Quarry Authorization/ Access Authorization	Access and work on Aboriginal private lands	Aboriginal private landowners
Land Access Permits	Inuit Owned Lands	Regional Inuit Associations (Nunavut)

2.2.1.1 Quarrying Fees

Royalty fees for granular material vary depending on the type and are specified in the Territorial Quarrying Regulations. Fees, based on an estimate of the amount of material required, must be submitted with the quarrying permit application. Outstanding balances will be returned if the amount of material used is less than estimated. During operations, the amount of quarried material must be tracked by monthly reporting of quarry returns to the local INAC office. A final plan, detailing the total volume of material used, is required when the total volume has been quarried or the quarrying permit expires.

For a quarry lease in Nunavut, fees are required as per the schedule in the lease.

2.2.2 Land Use Permit

If quarrying activities include the use of equipment that exceeds the thresholds of applicable land use regulations, a land use permit is required. Site investigation techniques conducted prior to quarrying that exceed thresholds of applicable land use regulations will also require a land use permit. Land use permits include specifications dealing with how operations must be conducted. More information can be obtained from the appropriate resource managers or regulatory boards, or by consulting applicable legislation and regulations. In Nunavut and the Inuvialuit Settlement Region, land use permits are issued under the *Territorial Lands Act*; in the Mackenzie Valley, they are issued under the *Mackenzie Valley Resource Management Act*.

Aboriginal rights must be respected when planning and conducting quarrying activities. INAC and other regulatory authorities strongly encourage community engagement as part of the permitting process. For example, proponents should contact local Aboriginal groups and communities to discuss their proposed development plans well in advance of submitting permit applications. Proponents can contact the applicable land use regulator in their region for more information on requirements for community engagement.

Site development can proceed once all applicable permits are issued. INAC is responsible for regular inspection and enforcement of quarrying and land use permit conditions on Crown land in both the Northwest Territories and Nunavut.

2.3 Carving Stone in Nunavut

In Nunavut, proponents are required to understand and follow provisions outlined in the Nunavut Land Claims Agreement (Article 19) respecting Inuit rights to carving stone on Crown land. Inuit have a largely unrestricted right to harvest carving stone, defined as serpentinite, argillite or soapstone, that is suitable for carving. The stone has both cultural and economic importance for Inuit.

Proponents must immediately report discoveries of carving stone in pits and quarries on Crown land to the local INAC district office. The Designated Inuit Organization then has the right to obtain an exclusive quarry lease if the deposit is significant or acquire title to the land containing the deposit through a land exchange process.

An Inuk has the right to remove up to 38 m^3 of carving stone per calendar year from Crown land without having to obtain a quarrying or land use permit as long as no significant damage is done to the land and it does not interfere with use and enjoyment of the land.

CHAPTER 03

Planning and Design

Proper planning is critical to conducting an efficient and environmentally responsible pit or quarry operation. The development objective is to maximize the use of granular resources while minimizing negative environmental impacts. To do this, the proponent should gain a thorough understanding of the site by collecting detailed site information during the early stages of the proposed development. The proponent should also create a complete plan for how the development will proceed from initial clearing through reclamation, called a pit/quarry development plan. This information will be required by regulatory authorities during the permitting process.

FIGURE 5. Ground truthing of site conditions is accomplished by field investigations.

3.1 Site Conditions

Pit or quarry development should include an assessment of site conditions as these will often dictate how and where development can proceed. Site assessment should take into consideration the quantity of material required, the duration of the operation and the mitigation of the environmental impacts. A review of existing information, such as aerial photographs, granular resource reports and existing land uses, should be conducted to identify suitable sites for further field investigations. There are a number of information sources that can be used to determine site conditions when planning and designing a granular resources operation. Some examples of information needs and sources are outlined in Table 3-1.

3.1.1 Field Investigations

Once a suitable site has been identified, field reconnaissance should be conducted to confirm interpretation of existing data and local environmental conditions. At the exploration stage, sensitive areas, such as slopes that are prone to erosion or areas of ice-rich permafrost, should be identified so that they can be avoided during the development stage. Overburden and granular materials should be tested for acid rock drainage or metal leaching potential and, if found, these areas should be avoided.

Non-intrusive geophysical surveys, using electronic instruments, can be conducted to delineate granular resources with little environmental disturbance.

Type and thickness of vegetation, overburden and interburden should also be assessed to determine the preparatory work required to access the deposit, and to ensure the deposit has adequate volume to meet user needs.

Advanced exploration of the granular deposit may be required to further understand the geological properties and size of the deposit. Activities such as drilling, test pitting or blasting, to obtain surface and shallow-depth granular samples, often include the use of equipment that exceeds the thresholds of applicable land use regulations, and will require a land use permit. Quarries for large-diameter armour stone require a more detailed field assessment to confirm that suitable material exists and that its extraction is feasible.

3.1.2 Permafrost

Continuous and discontinuous permafrost are present throughout the Northwest Territories and Nunavut. Assessment of a potential granular resources site should include observations of local

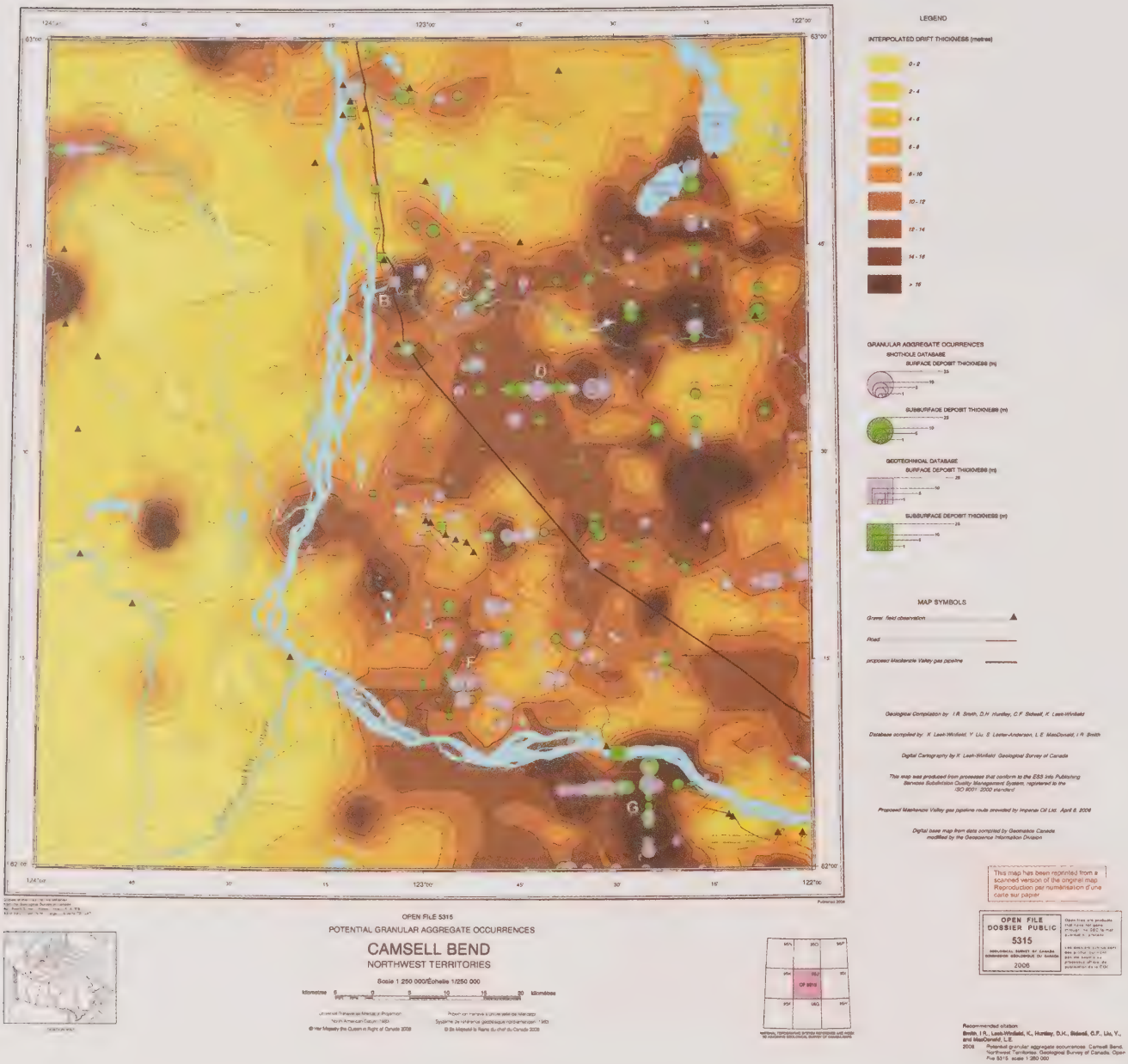

FIGURE 4. Existing granular information. (Natural Resources Canada)

Table 3 1. Information used for pit and quarry planning

INFORMATION TYPE	INFORMATION NEEDS	INFORMATION SOURCES
Surficial geology	• Type, extent and grade of deposit • Soil and overburden • Acid rock drainage or metal leaching potential • Extent of permafrost and ground ice	• Local INAC office • Northern Granular Resources Inventory www.ainc-inac.gc.ca • Northwest Territories Geoscience Office www.nwtgeoscience.ca • Nunavut Geoscience www.nunavutgeoscience.ca • Natural Resources Canada, Geoscience Data Repository www.gdr.nrcan.gc.ca • Local operators • Applicable land use plans
Environmental	• Topography and drainage • Surface vegetation • Sensitive landforms (e.g. pingos or eskers) • Water management • Timber/forestry • Fish and wildlife habitat	• Aerial photographs and maps • Local INAC office • Appropriate resource managers or regulatory boards • Local operators and residents • INAC Water Resources Division www.ainc-inac.gc.ca • Government of the Northwest Territories, Environment and Natural Resources www.forestmanagement.enr.gov.nt.ca • Fisheries and Oceans Canada www.dfo-mpo.gc.ca • Environment Canada www.ec.gc.ca
Archaeological/cultural	• Location of archaeological sites • Traditional use areas (e.g. berry-picking sites, traplines, cabins)	• Prince of Wales Northern Heritage Centre (Northwest Territories) http://pwnhc.learnnet.nt.ca • Department of Culture, Language, Elders and Youth (Nunavut) www.gov.nu.ca/cley • Inuit Heritage Trust (Nunavut) www.ihti.ca
Existing land uses	• Existing pits and quarries, access roads and disturbances • Other land users	• Local INAC office • Appropriate resource managers or regulatory boards

permafrost conditions because ice-rich permafrost is prone to subsidence and slumping when it thaws, which can negatively impact quarrying operations.

In permafrost regions, field investigations should determine the extent, depth and ice content of permafrost at a proposed pit or quarry site before proceeding with development. Early identification of ice-rich permafrost will ensure that measures can be implemented to mitigate its degradation, or an alternative location can be developed where permafrost is absent.

If ice-rich permafrost cannot be avoided, measures to mitigate its degradation include conducting work during the winter and replacing the organic layer prior to spring thaw to provide an insulating layer between the permafrost and warm air temperatures. If ice-rich material is excavated, it should be piled in rows and allowed to melt and drain before use. More information on land use operations in permafrost areas is available in the *Permafrost* volume of this series.

FIGURE 6. (top) Permafrost can be ice-rich as demonstrated by this exposed ice wedge.

FIGURE 7. Melting of ice-rich permafrost can cause subsidence and erosion.

3.2 Site Design

Consideration of site design prior to development will result in an efficient operation with minimal environmental disturbance. A goal of site planning should be to minimize the area of disturbed land; however, there should be enough room to conduct all phases of development safely. For example, there should be adequate room to pile overburden during site development and granular materials during operations.

Site design for a quarry is usually more complex than for a pit because of safety concerns associated with blasting, and pit wall and bench design. Territorial mine safety legislation dictates how a quarry must be designed and developed. Land use permit conditions may also specify some design criteria, but the site design should be well defined at the time permit applications are submitted. This section outlines specific factors that should be considered during the planning phase of pit and quarry development.

3.2.1 Access

To reduce the area of land used in pit or quarry development, existing access routes, including roads, trails and seismic lines, should be used where available and safe. If a new access route is required, it should be kept to the minimum width necessary for safety. Ideally, only a single access route is required to enter and exit the pit or quarry, with vehicles turning around within the pit or quarry. Further information on access planning is available in the *Access: Roads and Trails* volume of this series.

3.2.2 Buffer Strips

Buffer strips are areas of land that are left untouched to provide a natural barrier between the development and an adjacent area. Buffers can be used to protect water quality by leaving riparian areas adjacent to water bodies intact, and they can be used to provide a visual barrier between the development and an area of human use. To ensure their stability and safety, buffers should be designed to resist damage from prevailing winds. When possible, buffer strips should also be designed to block road surfaces from direct sun exposure because direct sunshine can cause unsafe glare-ice conditions on road surfaces.

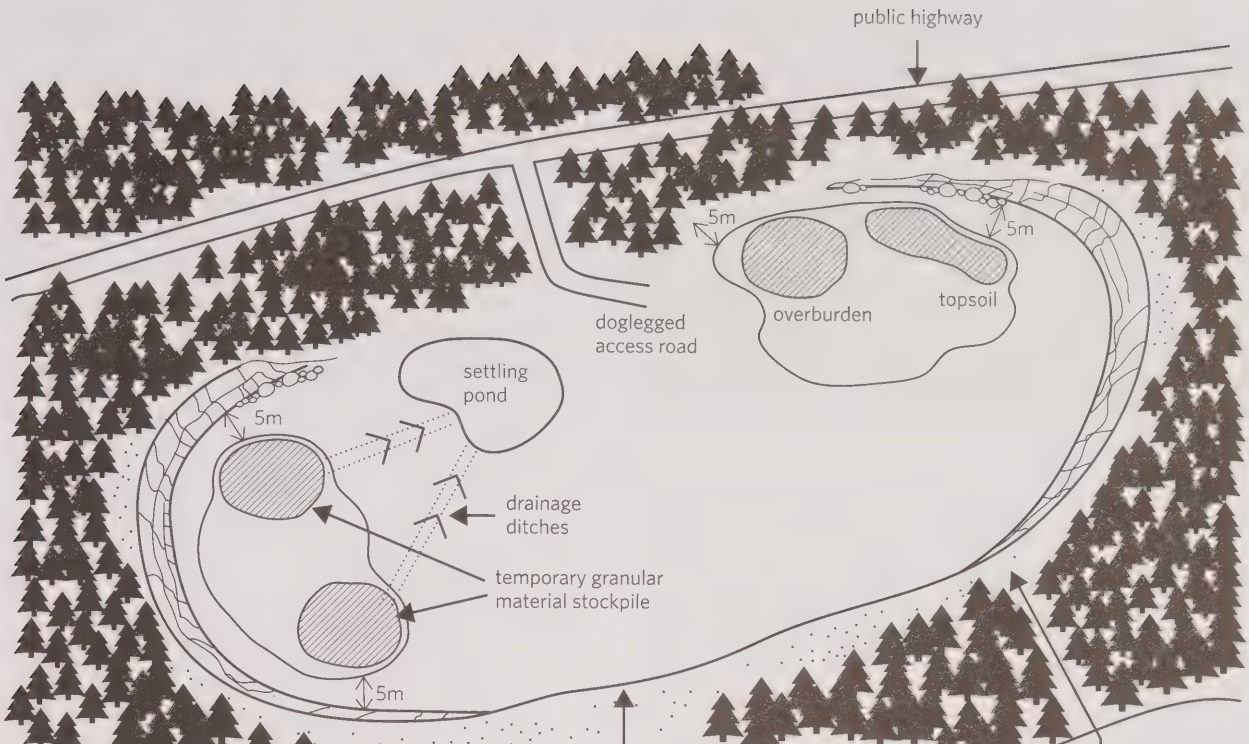

FIGURE 8. A well-designed quarry.

In the Mackenzie Valley, buffer strips of at least 100 m width, extending from the ordinary high water mark, are required between quarry developments and water bodies. In the Inuvialuit Settlement Region and Nunavut, buffer strips adjacent to water bodies are required to be at least 30 m wide.

3.2.3 Visual Impacts

Minimization of visual impacts to areas of human use, such as a highway, should be considered when designing a pit or quarry site. Land use permits may have specific conditions regarding the appearance of a development site. Recreation sites should be avoided, along with areas of heavy public use and highly visible locations.

If areas of public use cannot be avoided, creating adequate buffers between the pit or quarry and other users is the most effective means of mitigation. Buffers can include a vegetated strip or a constructed earth berm. A pit or quarry may also be eliminated from view by locating it on the downhill side of a road or creating a doglegged access road.

3.2.4 Noise and Dust

Noise and dust from pit or quarry operations can be a nuisance in areas with other land users nearby. Excessive dust can also be an occupational hazard for those working on-site, and can also affect wildlife. To minimize noise and dust, consider prevailing winds when designing the site and orient quarry faces to direct noise and dust away from other land uses. If this is not possible, consider constructing an earth berm to block noise and dust.

FIGURE 9. A well-designed pit with a doglegged access and vegetated buffer zones

3.2.5 Progressive Reclamation

The pit or quarry should be designed with eventual reclamation of the site in mind and how this work will be carried out progressively throughout operations to minimize the impact of the pit or quarry on the environment. For example, a depleted quarry face can be reclaimed using overburden and soil from land that is to be cleared for the next face. This will reduce the amount of time that the land is disturbed and will increase the length of time the proponent will have to evaluate the success of reclamation techniques. There is also an economic advantage to progressive reclamation during operations as machinery and resources are already on-site.

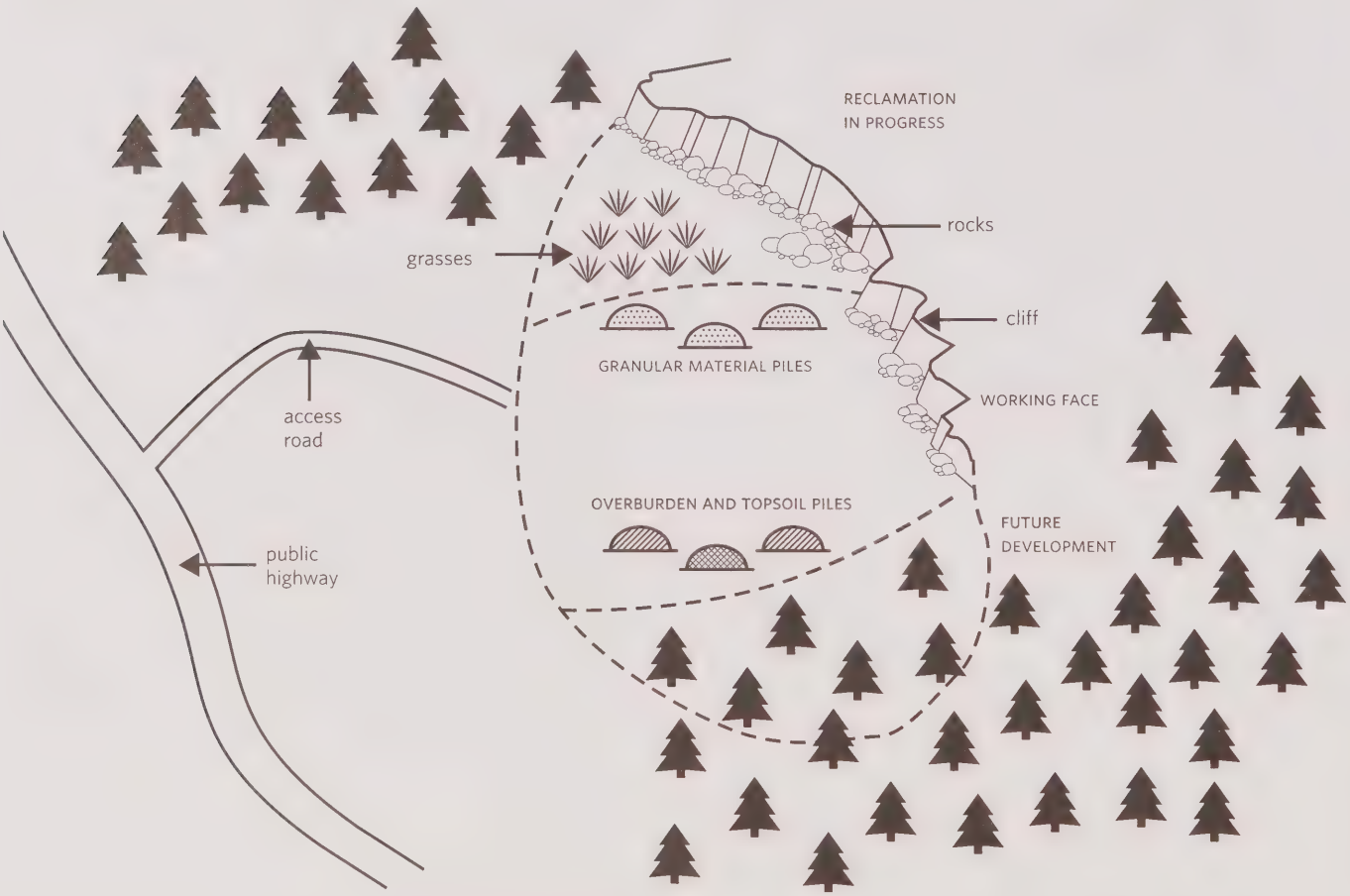

FIGURE 10. A pit that is being progressively reclaimed during operations.

3.3 Water Management

The flow of water into and out of a proposed pit or quarry site should be minimized to enhance the efficiency of operations, limit the effects of sedimentation on water quality and prevent permafrost degradation. Water management planning should consider both water quantity and quality. For instance, removal of vegetation and overburden will influence local water quantity by increasing the volume and rate of recharge into the groundwater system. Water quality may be affected by acid rock drainage or metal leaching from piles and the pit walls, or blasting residue, such as ammonia. Important changes to drainage characteristics due to pit or quarry development include:

- changes to natural drainage patterns;
- impermeable surfaces, such as clay layers, may inhibit drainage;
- steeper slopes may become unstable and contribute to erosion; and
- changes on adjacent properties may impact drainage at the pit or quarry site.

To avoid problems associated with operating in water, proponents should not excavate the pit or quarry below the water table, and seasonal and storm-related fluctuations in groundwater levels should be accounted for in the planning stage. The proponent should have an understanding of the maximum expected water flow in the project area, and plan water management structures to accommodate for peak periods of thaw and precipitation. Information on water levels may be obtained from Environment Canada, INAC Water Resources Division and local operators.

In permafrost areas, ponded water in low-lying areas of a pit can lead to permafrost degradation. Proper drainage can be promoted by sloping the pit floor away from the pit face, and installing drainage ditches or channels. In non-permafrost areas, water within a pit or quarry should be directed to a low-lying area within the pit or quarry where ground infiltration or evaporation can occur.

Pit or quarry water cannot be discharged to surface waters without obtaining an appropriate water licence that will specify water quality discharge limits. Treatment may be required before discharge

FIGURE 11. (top) Drainage ditches can be used to direct water to a settling pond within the pit.

FIGURE 12. (middle) Settling ponds can be used to manage pit water.

FIGURE 14. (bottom) Vehicular access to northern developments is often best accomplished during the winter.

to the environment. If dewatering of the pit or quarry is required, it should be directed to a holding pond or ditch that is well away from the top of a slope where erosion could occur.

Measures should be taken to prevent migration of silt into water bodies. Spreading slash or constructing shallow benches on an eroding slope can slow down runoff and erosion. Settling ponds or impoundments can be constructed to control surface runoff. Erosion control supplies, such as erosion control mats and blankets and silt curtains, should be kept on hand to respond to slope destabilization caused by water erosion.

3.4 Development Timing

Development timing is an important consideration in the North as many sites are more easily accessible by winter road when the ground is frozen, thereby minimizing land disturbance. Surface disturbance is more likely when the ground is saturated, particularly during spring breakup. In northern Canada, spring breakup generally occurs between March and April, and fall freeze-up occurs between October and November. Different stages of pit or quarry development should be scheduled at the most appropriate time of the year as suggested in Table 3-2.

3.5 Pit/Quarry Development Plan

To document the results of the planning stage, a pit or quarry development plan should be developed that outlines the entire project life cycle, including site conditions and design, planned operations and reclamation. The size and duration of the operation will determine the scope and level of detail required in the plan. A pit/quarry development plan template is presented in Appendix B.

At a minimum, the plan should include a 1:5000 scale site map illustrating the proposed layout of the operation, including the area of identified granular resources and proposed quarrying, existing access or clearing, the proposed overburden storage area, blasting locations and other infrastructure, such as camps. In addition, a description of proposed mitigation measures to address all identified environmental concerns should be included. Table 3-3 outlines common environmental concerns that may be encountered during site development or operations phases and related mitigation options, which are discussed further in subsequent sections of this volume.

FIGURE 13. Ensure pit excavation is well above the summer water table. (Redrawn from Robertson and Brandt, 1997, p. 31.)

Table 3-2. Suggested timing for development activities

ACTIVITY	SUGGESTED TIMING
Exploration	Vehicular access and test drilling are more appropriate during the winter when the ground is frozen, but sampling activities that require unfrozen ground, such as test pitting, must be conducted during the summer.
Access	Vehicular access requires winter roads, unless construction of an all-season road is planned.
Operations	To avoid rutting and surface disturbance, operations may need to be limited during the spring melt period. Critical life stages for fish and wildlife may limit operations during the spring and fall. To avoid disturbance of permafrost in ice-rich areas, work should be conducted during the winter.
Closure and reclamation	Recontouring slopes for drainage, and replacing overburden and topsoil are best done during the summer when the ground has thawed and is well drained. Active revegetation, such as seeding, can be done during the fall so that the winter snow layer can provide plants with a water source the following spring.

Table 3-3. Pit and quarry environmental concerns and mitigation techniques

DEVELOPMENT PHASE	ACTIVITIES	ENVIRONMENTAL CONCERNS	POSSIBLE MITIGATION TECHNIQUES
Site design and development	• Timber and vegetation clearing • Overburden removal	• Habitat loss • Soil erosion • Sediment deposition	• Minimize project footprint • Identify and avoid environmentally sensitive areas • Locate the development in a well- drained area • Maintain natural drainage patterns • Retain vegetation buffer zones to maintain slope stability and protect water bodies • Construct ditches to direct runoff away from the site • Salvage and properly store organics, topsoil and overburden for use during reclamation
Operations and monitoring	• Blasting • Excavating • Crushing • Piling material • Access road maintenance	• Soil erosion • Sediment deposition	• Limit sediment movement using erosion controls (e.g. silt fence) • Use rip-rap to reinforce drainage channel corners and water discharge points • Use settling ponds before discharging water • Revegetate where required to stabilize slopes
		• Fuel spills • Blasting residue	• Use proper fuel containment and explosives-handling techniques
		• Permafrost degradation	• Limit pit or quarry depth to the active layer • Minimize in-pit water by directing surface water away from the site • Thaw ice-rich material at a location where meltwater will not re-enter the pit
		• Dust generation	• Use water and dust skirts on conveyors to minimize dust

FIGURE 15. Site design diagram to be submitted with a pit/quarry development plan. (Redrawn from Robertson and Brandt, 1997, p. 64.)

In pits or quarries on federal Crown land where multiple users are anticipated, an overall management plan will be developed by INAC. Each proponent will be required to provide a pit/quarry development plan detailing how they will operate within the constraints outlined in the overall management plan.

CHAPTER 04

Site Development

Development of a pit or quarry site should proceed in an orderly sequence to ensure that erosion of soils and deposition of sediment into water bodies are minimized, and that materials overlying the granular resource are properly segregated and stored for future use during reclamation. This section outlines measures that should be used in the development of a pit or quarry site.

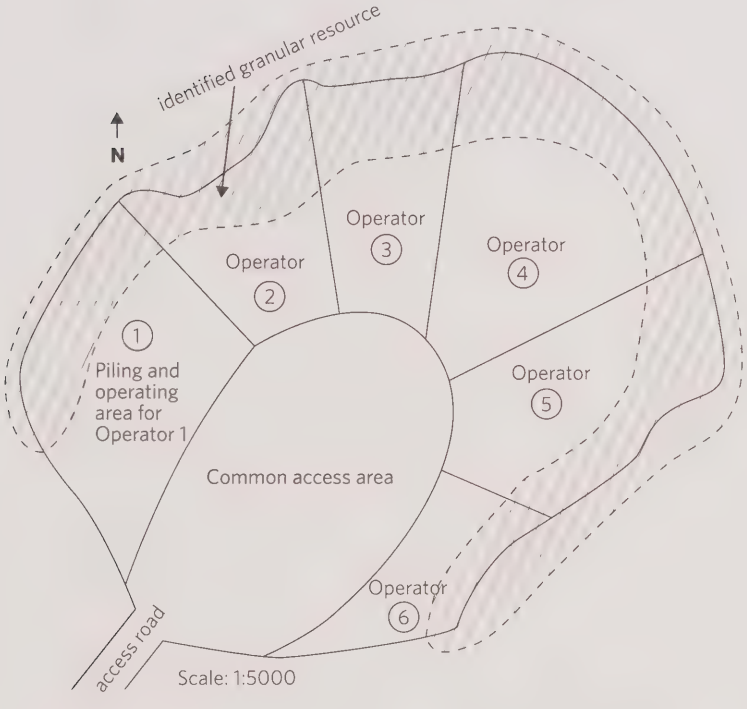

FIGURE 16. Planned site layout for a multiple-user pit.

4.1 Clearing

Clearing of vegetation has both a visual and an environmental impact, and it is good practice to avoid clearing a larger area than is necessary for the development. The pit or quarry boundaries should first be flagged to delineate the project area and restrict the project footprint. If applicable, the next step is to clear trees and shrubs within the project area. To reduce the length of time a site is disturbed, clearing should normally commence just prior to extraction. However, in areas of ice-rich permafrost, where winter operations will be conducted, it may be more effective to clear the site in the preceding fall. Clearing ice-rich sites during the summer should be avoided as this will expose the soil to direct sunlight and lead to ground-ice melting and subsidence.

Trees should be cut flush with the ground, unless clearing takes place when there is snow cover. In either case, tree stumps should extend no more than a maximum of 20 cm from the ground surface. Leaning trees should be cut down and made to lay flat on the ground to avoid damaging adjacent trees and for safety. Trees may also be mulched into wood chips that can be useful for stabilizing disturbed permafrost by insulating the ground. Land use permits may include conditions for saving and stacking merchantable timber. In general, trees larger than 12 cm in diameter should be saved. For more information, contact the Department of Environment and Natural Resources, Government of the Northwest Territories.

FIGURE 17. Merchantable timber can be saved and stacked for transport.

FIGURE 18. Leaning trees should be cut down and stacked into windrows.

Handling of cleared brush will be specified in the land use permit, or by an INAC resource management officer, and may be burned or piled for future use during site reclamation. Burning of brush is best accomplished in the fall or winter to minimize the risk of losing control of the fire. Brush can be compacted into long windrows that should be at least 5 m away from standing timber to reduce the hazard of a fire. Breaks of approximately 10 m width should be left in the windrow at approximately 300 m intervals to reduce blockage of wildlife movement.

In some cases, trees or shrubs can be saved and stored during site development for later use during reclamation to anchor the soil or to blend in with the surrounding landscape.

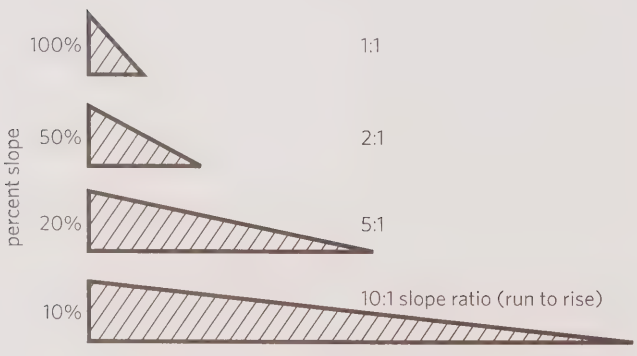

FIGURE 21. Slopes can be expressed as a ratio of the horizontal run over the vertical rise, or as a percentage. (Redrawn from Robertson and Brandt, 1997, p. 47.)

4.2 Soil and Overburden

The next step in site development is removal and piling of soil and rock overburden for future use during site reclamation. In many areas of northern Canada, soil layers are very thin or non-existent and this step may not be required. Organic topsoil, mineral soil and rock overburden layers should be stripped and piled separately to minimize mixing as they will have different functions during site reclamation. Rock overburden and mineral soil will be used for landscape reconstruction, whereas organic topsoil will be replaced on the surface to act as a natural native seed bank to support revegetation (see Section 7.4).

Soil and overburden piles should be located where they will not interfere with pit operations, and should be at least 5 m away from standing timber so that there is working space behind them. It is also important that the piles be placed in a location that will not interfere with surface runoff, and will allow for drainage of meltwater from ground ice. Organic topsoil can dry out quickly and can easily blow away or erode, so piles should be gradually sloped and rounded to minimize wind and water erosion. Structures to collect and treat runoff from piles may be required if the water has a high silt content. For safety, soil and overburden piles should be sloped to have a horizontal to vertical ratio of 2 horizontal to 1 vertical or greater.

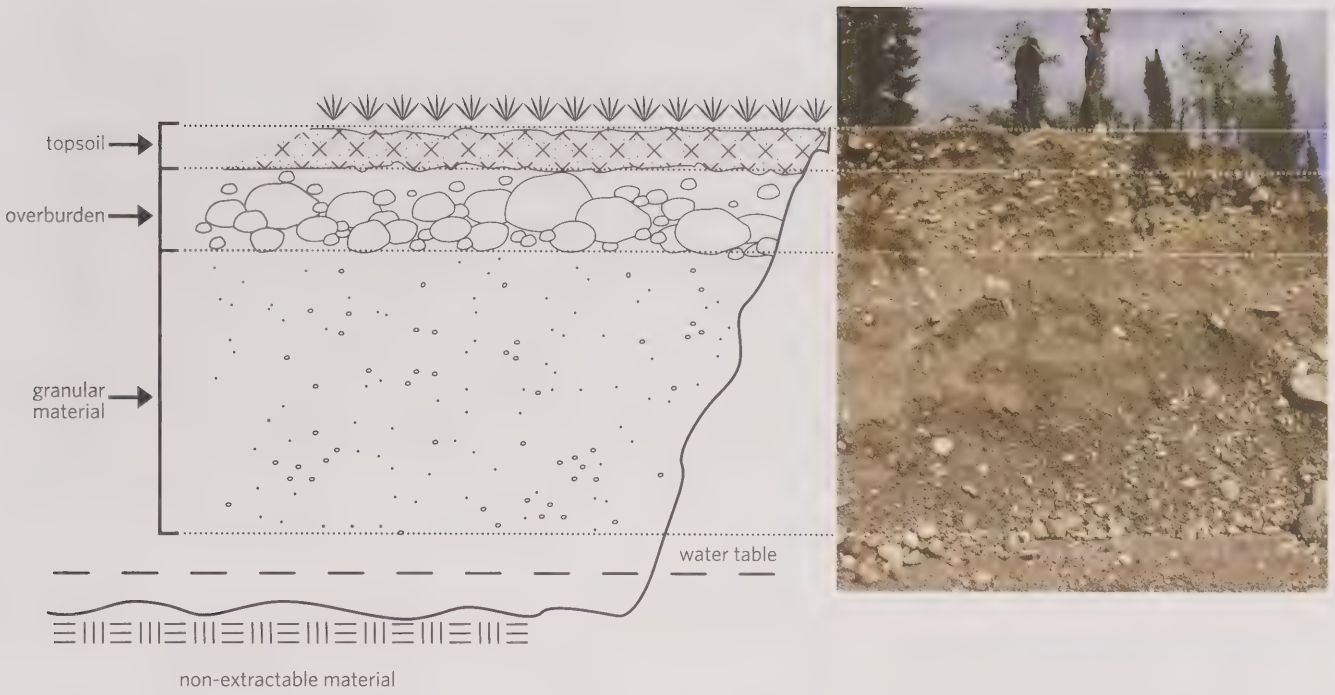

FIGURE 19. Typical stratigraphy of a pit or quarry site showing topsoil and overburden layers over granular material.

FIGURE 20. Overburden and woody debris should not be mixed, and piles should be at least 5 m from standing timber.

CHAPTER 05

Operations

The operations phase of quarrying includes extraction and processing of granular material at the site. Throughout operations, monitoring should be conducted to determine if the measures chosen to mitigate environmental concerns are working, and maintenance should be adaptive to ensure that mitigation techniques continue to work or are replaced. Operations must be conducted in accordance with approved management plans associated with the land use permit. Major changes in operations may require amending the land use permit or obtaining additional permits.

5.1 Resource Extraction

The method used to excavate granular material will depend on the nature of the material, the equipment available, and, in permafrost terrain, the extent and nature of the permafrost. Safe slope angles, wall heights and bench widths are determined by territorial mine safety legislation.

Temporary granular material piles stored in the pit should have stable slopes with a horizontal to vertical slope ratio of at least 2:1. If excavated material contains ground ice, it should be stored at a location within the pit where it can thaw and drain. Placing the material in small piles will allow it to thaw during a single summer season by exposing a larger surface area to direct sunlight.

Interburden waste material encountered within the desired granular material should be piled in a depleted section of the pit, and can be handled in the same way as overburden (see Section 4.2).

5.2 Resource Processing

Processing granular material usually requires an area of intensive heavy equipment activity, including crushers, screens, wash plants, generators and conveyors, and should be carried out on hard and stable ground within the pit. Each processing step requires an accessible area within the pit to carry out the operation, pile the processed material and allow trucks safe access to haul the material out of the pit.

Processing activities can generate considerable noise and dust, so it may be appropriate to restrict these operations during sensitive times for other land users or wildlife. Dust suppression controls, such as watering, using a dust skirt and minimizing the drop height when releasing material from a conveyor, are recommended to protect worker health and safety, and the environment.

Screening frozen material often leads to wastage caused by the presence of large frozen blocks. Wastage can be much reduced by waiting until the material has thawed. Alternatively, frozen material should be crushed before it is screened. Oversized materials, such as boulders that are rejected for resource use, should be stored and used for future reclamation activities.

Operations that require washing of granular materials may require a water licence for the use and disposal of wash water. Treatment of water from washing operations may be required to meet water quality objectives.

FIGURE 22. Extraction of rock involves drilling and blasting.

FIGURE 23. Excessive dust caused by crushing operations can be mitigated by spraying water or using dust skirts on conveyors.

5.3 Monitoring and Maintenance

The site should be monitored throughout operations to confirm that measures chosen to mitigate environmental concerns are working, to assess the performance of engineered structures, and to ensure that local regulations and conditions specified in the land use permit are being followed. Monitoring should be conducted regularly so that problems can be identified quickly. Early detection of a problem should trigger the appropriate response or contingency plan, and notification of the INAC resource management officer.

Regular monitoring should determine if environmental mitigation measures are achieving their goals, and should answer the following questions:

- Are the water management strategies effective?
- Are noise and dust mitigation measures effective?
- Is permafrost degradation occurring?
- Are spill-management plans being followed?

Regular maintenance of the site and infrastructure will ensure that environmental mitigation measures continue to be successful. In particular, the site and access roads should be regularly maintained to minimize erosion, sediment deposition and dust emissions. Potholes, washboarding and frost heaves should be promptly repaired to minimize dust generation and equipment wear.

5.4 Site Security

For safety and security, access to a pit or quarry site should be limited. Contact an INAC resource management officer for more information on appropriate access control methods.

5.5 Intermittent Operations

If a pit or quarry is to be closed seasonally, the proponent should inform regulatory authorities before operations are suspended. The pit or quarry must be stabilized before the operation is shut down by backfilling, contouring and reclaiming areas where extraction of granular resources is complete. Proper drainage must be in place to prevent flooding of the pit or quarry. If site conditions do not allow for positive drainage, intermittent operations may be impractical (this should be identified at the planning stage). If the proponent plans to store machinery, buildings or other materials at the site for future use, the proponent should request a storage authority from the local INAC office.

CHAPTER 06

Spills

Spills can involve chemicals, hydrocarbons or other hazardous materials. Spills of reportable quantities must be reported immediately to the 24-hour spill line at 867-920-8130. A list of immediately reportable spill quantities is available in INAC's *Guidelines for Spill Contingency Planning* (http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/SCP-eng.asp).

6.1 Spill Contingency Plan

A spill contingency plan must be in place during all phases of pit or quarry development, and must be submitted with the land use permit application. Unexpected spill events do occur and a plan will help operators respond to them quickly and effectively. The spill contingency plan should be implemented immediately after a spill event. The plan outlines a logical order of how operators should respond to a spill, resources available on-site for spill response, and agencies and individuals that need to be notified. All personnel working on the site should be aware of and understand the plan so that they can respond effectively to a spill. A spill contingency plan template is provided in INAC's *Guidelines for Spill Contingency Planning*.

6.2 Spill Prevention

Hydrocarbon spills from equipment are a major source of environmental damage and are often preventable. Equipment should be properly maintained and in good working condition to minimize potential leaks from hydraulic hoses and other working components. Drip trays can be placed under equipment when not in use to catch hydrocarbon drips.

6.3 Spill Response

Spill response includes stopping, containing and reporting the spill event. A spill response kit should be available on-site that is well stocked with materials that can be used to contain a spill. Once a spill has been contained and reported, photographs should be taken of the spill area, the extent of the spill should be delineated and a cleanup strategy should be developed. Ensure that there is never an ignition source in the vicinity of spilled flammable products.

CHAPTER 07

Closure and Reclamation

The final phase of pit or quarry development is closure and reclamation. The overall reclamation objective is to return the disturbed area to a stable, useable condition. Where several future land use options exist, the highest and most productive use should be chosen. Environmental limitations, nearby communities, land users, site visibility and existing regional land use plans will all influence the reclamation objectives that will be determined by the land use regulator. The overall reclamation objective for the majority of pit or quarry sites in the Northwest Territories and Nunavut is to return the site to a natural condition that blends in with the existing topography and surrounding landscape.

A closure and reclamation plan is required under the conditions of the land use permit. This plan should be developed with input from local communities and land users, regulatory authorities and the INAC resource management officer. Land use permits may also contain specific conditions regarding reclamation.

Once a closure and reclamation plan is approved, progressive reclamation may be conducted during operations at areas of the site that are no longer used. This will reduce the amount of reclamation required when operations are completed, will allow for evaluation of reclamation techniques, and could reduce reclamation costs at the end of operations by using equipment and resources that are already on-site.

When operations are complete, the site must be reclaimed as per the reclamation objectives outlined in the closure and reclamation plan. Monitoring will be required for several years after the reclamation work was conducted to ensure that the reclamation objectives are being met. If the reclamation objectives are not being met, proponents will be required to return to the site to carry out further reclamation work. Once the land use regulators are satisfied that the site is stable and the reclamation objectives have been met, a letter of final clearance will be issued indicating that the permit holder is no longer responsible for the pit or quarry site.

FIGURE 24. This pit has been recontoured and left to revegetate naturally.

7.1 Site Cleanup

At the end of operations, all materials and debris must be removed from the site, including buildings, machinery, fuel containers, garbage, blasting materials, granular material, overburden and soil piles. If hydrocarbon-contaminated soils are to be remediated on-site, the appropriate regulatory agency should be contacted to determine the method of cleanup (this must be documented in the closure and reclamation plan).

FIGURE 25. All waste must be removed from the site at closure.

7.2 Landscape Reconstruction

Most pit or quarry sites will require some landscape reconstruction for safety, to prevent erosion, and to reduce visual impacts. Loose material should be removed from pit walls by scaling cliff faces and removing overhang at the top of the wall.
The tops of excavated slopes should be rounded to reduce the chance of slumping, except in areas of continuous permafrost where they should be left to avoid disturbing the permafrost. For safety, a reclaimed pit slope should have a slope ratio of at least 2:1, or the natural angle of repose, whichever is greater, and steep slopes should be stepped.
A geotechnical engineer should be consulted for contouring of any slope higher than 5 m.

Rock overburden and mineral soil that were removed and stored at the beginning of operations should be used to contour the site. Use of frozen material for reconstruction activities is not recommended as the ground ice it contains may melt and cause subsidence. If sufficient overburden is available, gentle slopes and rounded shapes are visually preferable to straight lines. Rock overburden can be spread over the bottom of the pit and used to reconstruct slopes. It will provide an insulating layer to prevent further permafrost degradation. Mineral soil can be placed above the overburden for site grading and contouring.

Once site contouring is completed and the ground surface has stabilized, stored topsoil should be placed on the surface to promote revegetation. Topsoil contains native seeds and organic material that expedite vegetation growth. For most land uses, topsoil should be spread over as much of the surface of the disturbed area and as close to the original depth as possible. Depending on closure objectives, however, differing depths of topsoil can result in a greater diversity of natural vegetation, and there may be situations where an undulating or irregular terrain is preferred for wildlife, wetland or recreational use. In steeply sloping areas where soil erosion may occur, topsoil should not be used.

If the soil is compacted, its ability to support plant growth is greatly reduced. During spreading of overburden and topsoil, use of rubber-tired equipment should be minimized as this can compact soils and destroy soil structure.
Soils should not be handled when they are wet and most susceptible to severe soil compaction. After spreading, the ground surface should be roughened to provide micro-sites suitable for revegetation. If soils become compacted, a combination of soil-ripping techniques and soil amendments can be used to loosen the soil and restore soil structure.

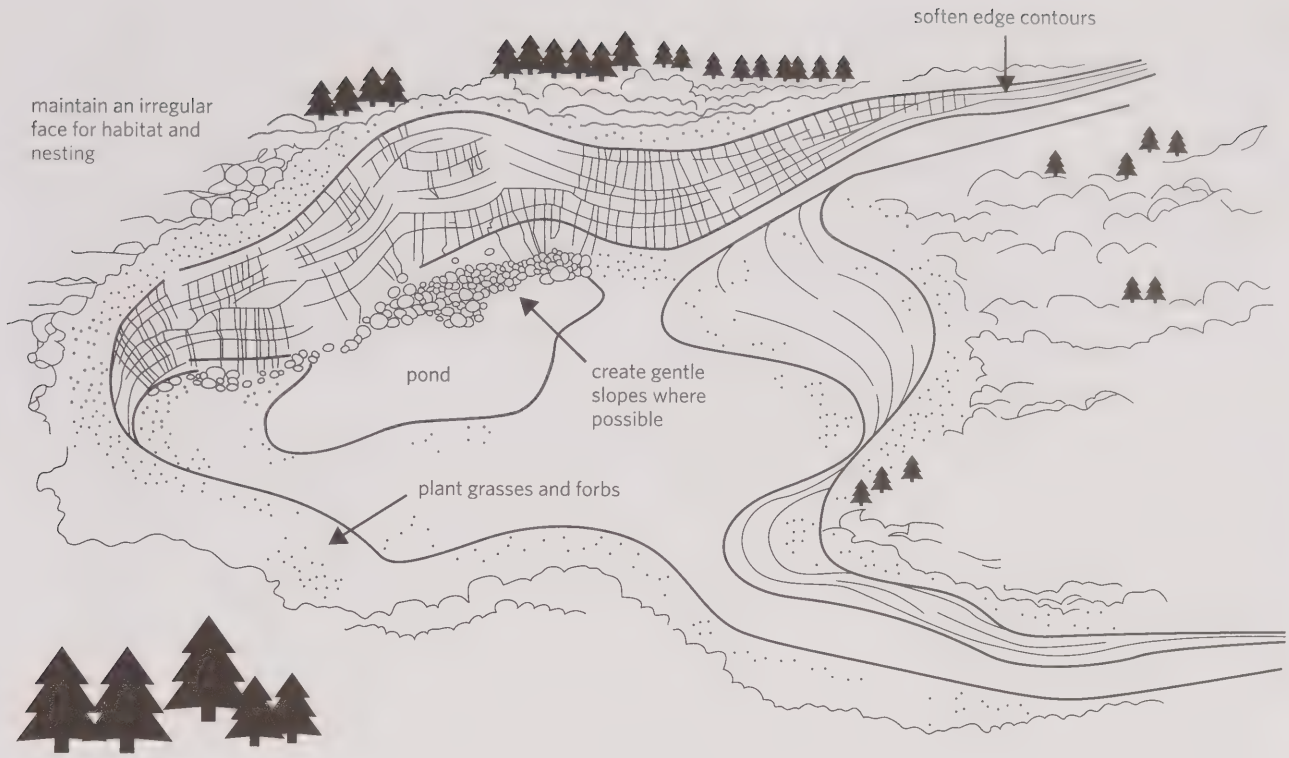

FIGURE 27. Closure and reclamation planning. (Redrawn from Robertson and Brandt, 1997, p. 20.)

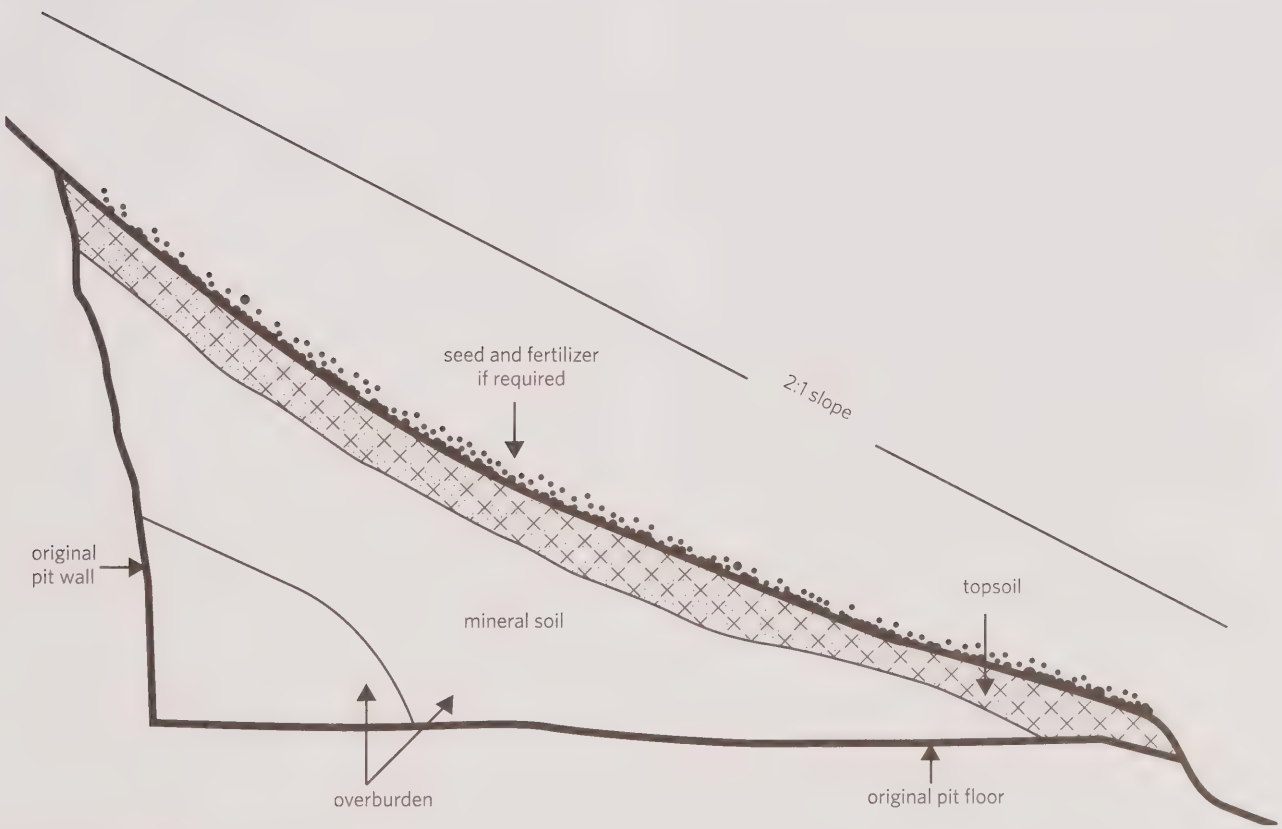

FIGURE 28. Proper placement of overburden, mineral soil and topsoil for reclamation. (Redrawn from Robertson and Brandt, 1997, p. 42.)

7.3 Drainage and Erosion Control

Successful reclamation includes well-designed surface drainage to control erosion. Site recontouring should not block or divert natural drainage patterns on the site as reclaimed areas are susceptible to erosion while vegetation and soil stability become re-established. Roughening exposed soil surfaces using horizontal grooves can improve drainage and minimize water ponding.

Slope grading and revegetation will, in most cases, serve to control erosion in the pit. However, at sites with greater surface flow, for instance, in permafrost terrain, additional drainage control measures may be necessary. These measures may include:

- constructing a berm or swale at the top of the slope to direct water away from or around the pit;
- laying brush across the slope to slow runoff and trap sediment; and
- directing runoff to the bottom of the slope through a drainpipe or ditch.

Drainage ditches should have adequate grade and capacity to divert runoff from the reclaimed site without eroding adjacent material. Rip-rap or boulders may be required to armour drainage ditch corners and discharge areas to prevent erosion from runoff. Construction and repair of drainage ditches should be performed during dry weather to avoid adding sediment to the water.

7.4 Revegetation

Revegetation objectives should be discussed with land use regulators, and will be specified in the closure and reclamation plan. The selected option should be based on the end land use, compatibility with the surrounding landscape and limiting factors such as climate, the surface material and the moisture-holding capacity of the surface material.

Allowing establishment of natural vegetation over time is preferred to seeding as it limits the introduction of invasive plant species that may be inadvertently included in seed mixes, and native plants are often more successful over the long term as they are adapted to northern growing conditions. Salvaged topsoil often contains seeds from native plants and organic matter that aid in establishment of natural vegetation. However, when slope erosion, dust or immediate aesthetic values are a concern, seeding of grass or legume species and the use of fertilizer may be desired to achieve revegetation objectives more quickly than would otherwise be possible through natural regeneration. Revegetation can also include planting trees or shrubs that were saved and stored when the pit was developed. Woody vegetation can anchor the soil and blend in with the surrounding landscape.

Where seeding is required, native seed mixes should be used to lower the risk of invasive species. Unfortunately, there is currently no commercial source of grass and legume seeds indigenous to the Northwest Territories or Nunavut. Instead, similar agronomic cultivars from Yukon, southern Canada, Alaska or continental United States must be used. Prior to using any seed mixes or fertilizers, or for more information on appropriate seed mixes and fertilizers, contact the local INAC office.

Seeding of non-native cultivars can be conducted in a way that encourages invasion of native species. Some seeded species will grow quickly and anchor the soil, but will eventually die back and provide a nutrient base for native species that invade the area.

FIGURE 30. This small borrow pit has been reclaimed as a pit lake.

7.5 End-Pit Lake

In permafrost terrain, the presence of a large body of water will lead to warming and subsidence of the ground, so allowing surface water to flood a pit and create a lake is not an acceptable closure objective. Positive drainage should be used to divert water away from the pit area to prevent formation of a lake.

If permafrost is not present, an end-pit lake may be an acceptable closure option. All economically viable granular material should be removed from the pit before flooding. The shoreline and slopes should be armoured or contoured so that they remain stable. Potential lake water quality, lake levels and connectivity with other water bodies should be considered in the reclamation planning stage. Proponents planning an end-pit lake should contact Fisheries and Oceans Canada.

7.6 Reclamation Monitoring

Site monitoring will be required for several years after reclamation activities are completed to assess whether the closure objectives have been met. Monitoring requirements will usually be specified in the land use permit. Post-closure monitoring should attempt to answer the following questions:

- Are erosion control structures performing as designed?
- Are water management techniques effectively controlling water going into and out of the pit?
- Has vegetation been re-established to predicted levels?

If monitoring demonstrates that some reclamation techniques have been unsuccessful, additional reclamation work may be required. When the land use regulator is satisfied that the site is stable and the reclamation objectives have been met, a letter of final clearance will be issued indicating that the permit holder is no longer responsible for the pit or quarry site.

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Glossary

Acid rock drainage/metal leaching

Outflow of acidic water or water high in dissolved metals from areas where the earth has been disturbed, such as mines. Acid rock drainage or metal leaching also occurs naturally within some environments as part of the rock weathering process.

Active layer

Layer of ground above permafrost that seasonally freezes and thaws.

Angle of repose

Maximum angle at which a slope can remain stable.

Armour stone

Stones or broken rock of larger size than rip-rap that are placed on an embankment for erosion control and protection.

Cultivar

Variety of a plant developed from a natural species and maintained under cultivation.

Dogleg

Sharp change in the direction of a road. Designed to conceal the road from view for aesthetic purposes.

Dust skirt

Sheet that surrounds the outlet of a crusher to contain and minimize dust emissions.

Ground ice

Ice present in ground materials. Important because it dominates the geotechnical properties of the material and can cause terrain instability if it melts.

Interburden

Waste material encountered within a granular resource.

Overburden

Rock or soil of little or no value located above the granular resource deposit. Must be removed prior to quarrying.

Permafrost

Ground frozen for at least two consecutive years. Continuous permafrost is defined as an area where at least 90 percent of the land area is underlain by permafrost. Discontinuous permafrost is defined as an area where 10 to 90 percent of the land area is underlain by permafrost.

Rip-rap

An erosion-resistant ground cover of large, loose, angular stones used to stabilize slopes and protect soil from the erosive forces of runoff.

Riparian

An area of land adjacent to a stream, river, lake or wetland containing vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas.

Windrow

Woody debris that has been piled into a long, continuous row.

Appendix A: Pit/Quarry Development Plan Template

A pit/quarry development plan should cover the following topics:

1. 1:5000 scale site map

2. Description of proposed mitigation measures to address all identified environmental concerns

3. Site Conditions
   - full delineation of granular resource
   - contours, elevations and drainage features
   - environmentally sensitive areas (e.g. streams, wildlife habitat)
   - extent of permafrost and ground ice
   - adjacent land uses

4. Site Design and Development
   - adequate room for all activities
   - topsoil, overburden and granular pile locations
   - proposed site development techniques (e.g. clearing trees, windrowing brush)
   - proposed or existing access routes
   - proposed or existing infrastructure (e.g. camps, refuelling areas)
   - design for water management and erosion control
   - design for progressive reclamation

5. Operations
   - resource extraction and processing techniques
   - single-season or multi-year operation
   - spill contingency plan
   - monitoring and maintenance plans
   - contingencies if changes to the original development scenario are required

6. Reclamation
   - closure objectives
   - removal of all garbage, debris, equipment and buildings
   - overburden replacement for site contouring
   - re-establishment of natural drainage
   - replacement of all salvaged topsoil
   - revegetation activities
   - reclamation of access roads

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